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APPRENTICESHIP TRAINING

**ELECTRONIC
TECHNICIAN
Program**

Alberta
MANPOWER

Apprenticeship and Trade Certification

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COURSE OUTLINE

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ELECTRONIC TECHNICIAN TRADE

THE GOAL OF APPRENTICESHIP TRAINING

To develop a competent tradesman who, through skill and knowledge, is capable of diagnosis and repair of radio and television receivers and other electronic equipment.

THE PRODUCT OF APPRENTICESHIP — a graduate who will:

- ★ understand electrical and electronic theory and its application to radio, television and other equipment such as record players, tape recorders and inter-communication systems.
- ★ be competent in the use of test instruments and understand their capabilities and limitations.
- ★ have the dexterity and skill required to carry out the mechanical functions of completing repairs after locating the fault.
- ★ be familiar with many different combinations of circuits and components.
- ★ be capable of working out test procedures to isolate and pinpoint defective components.
- ★ be able to meet the public and deal effectively with the customer, both in the shop and in the home.

APPRENTICESHIP INFORMATION

Basic Requirements:

- ★ Indenture for four periods of Trade experience.
- ★ Attend a 12 week technical training course in the first and second periods and a 6 week technical training course in the third and fourth periods.
- ★ Fulfill the requirements for each period including 1800 hours of work experience inclusive of time spent at the training course; successfully complete the technical training course and obtain a satisfactory employer's report.
- ★ Education — a minimum requirement is the completion of grade 10 including a "B" standing in Math 10 or pass entrance examination as prescribed by the Trade Regulation.
- ★ Age — the minimum age for apprentices is 16 years. There is no upper age limit.

Credits:

- ★ Accelerated patterns of apprenticeship may be granted for related technical training and/or experience.

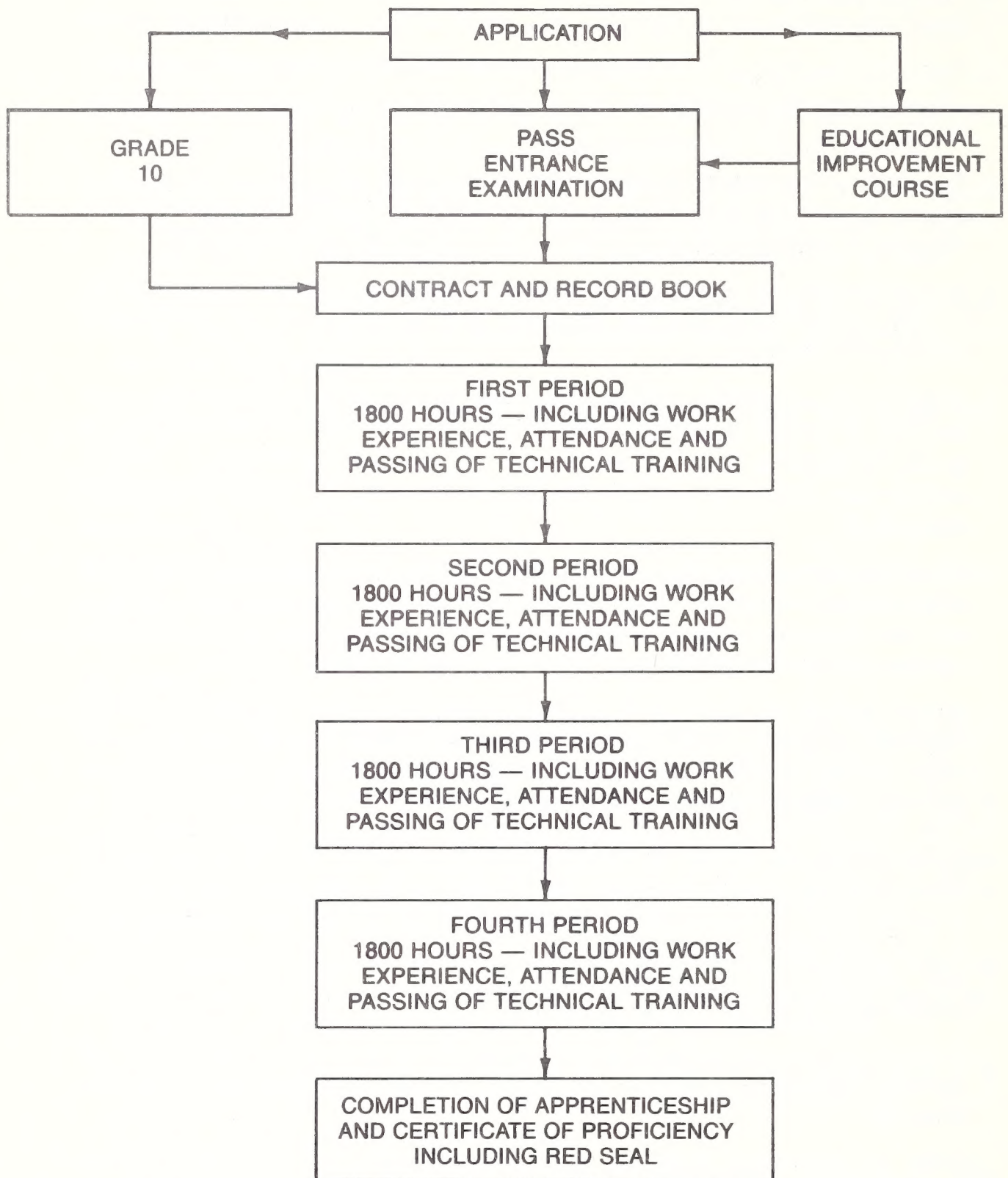
Benefits:

- ★ Apprenticeship is a learning-while-earning program. During the apprenticeship period, while working at the trade, apprentices are assured by regulation of a minimum percentage of the prevailing journeyman rate: 50% during the first period, 60% during the second period, 70% during the third period, 80% during the fourth period. Progress from one rate to the next takes place only after successful completion of all the requirements for each period. (details are outlined in the Record Book).
- ★ All apprentices 17 years of age and older are normally eligible for training allowances while attending technical training courses. These allowances are funded by the Canada Employment and Immigration Commission.
- ★ Administrative procedures establishing the amount of training allowance is complex and can vary with an individual's circumstances. Contact a local Canada Employment Centre for details.
- ★ An apprentice who successfully completes the program will graduate with an Alberta Completion of Apprenticeship Certificate and a Certificate of Proficiency. It is also possible for the graduate to obtain an interprovincial Red Seal by passing an additional examination and so become recognized as a qualified tradesman throughout Canada.
- ★ The most significant benefit to the graduate apprentice is that he is well trained in technical and practical aspects of the trade and is able to make a worthwhile and productive contribution to society. Society in return, will provide an opportunity for livelihood.

DIRECTIONS FOR PROSPECTIVE APPRENTICES

- ★ Contact your nearest Apprenticeship and Trade Certification office for detailed information and counselling (see list of offices on page 58).
- ★ Obtain an application form from the Apprenticeship and Trade Certification office and neatly complete, in full, the information requested of the apprentice.
- ★ Persevere in the search for apprentice employment and upon obtaining employment, give the application to the employer. It should be completed and returned to an Apprenticeship and Trade Certification office forthwith.
- ★ Any time credit, for previous experience in the Electronic Technician trade, should be discussed with the employer and requested on the application form by the employer.
- ★ Attach to the apprentice application a copy (transcript) of the marks for your last year of school. Applicants who do not have their school transcripts or a grade 10 standing are required to write an entrance examination. If transcripts have been lost, contact Alberta Education for information on school transcripts.
- ★ A contract of apprenticeship is entered into between the apprentice and the employer and should be signed within 90 days after the apprentice application has been approved. If contracts have not been issued within this time, contact the Apprenticeship and Trade Certification office.
- ★ Before signing the contract of apprenticeship read the complete document carefully — know your obligations and responsibilities to your employer — know the employer's obligations and responsibilities to you — feel confident you have selected the right occupation.
- ★ Know when you will be expected to attend classes and be prepared to attend. In early May of each year, School Schedules are sent to you and your employer. The employer also receives a class selection card for you, which is to be completed and submitted for scheduling. Information on procedures also accompanies the above. Confirmation on the date you actually get scheduled and/or the Official Notice will follow at the appropriate time(s).
- ★ Prepare in advance for the financial obligations required of you during school training. Reference materials and school supplies are paid for by the apprentice.
- ★ While an apprentice, it will be your responsibility to respond promptly to mailed directions and requests from Apprenticeship and Trade Certification.

APPRENTICESHIP ROUTE TOWARD CERTIFICATION



APPRENTICESHIP COMMITTEE STRUCTURE

Electronic Technician Provincial Apprenticeship Committee

The Provincial Apprenticeship Committee for the Electronic Technician Trade is comprised of members from Local Apprenticeship Committees from the cities of Edmonton, Calgary and Red Deer.

This Committee is concerned with the policies that guide the program and make recommendations to the Apprenticeship and Trade Certification Board and the Executive Director of Apprenticeship and Trade Certification in the following areas:

- ★ Contribute current information relative to changes in the trade and requirements of industry.
- ★ Make recommendations for changes to existing trade regulations.
- ★ Assist in updating of the training program through recommendations for revisions to the course outline and attendant examinations.

Electronic Technician Local Apprenticeship Committee

Local Apprenticeship Committees are concerned with individuals and trade situations within a local region. Meetings are held throughout the year to make recommendations and to discuss problems relating to the apprenticeship program. Members who serve on committees are nominated by employer and labour organizations, and membership is equally divided into employer and employee representation in accordance with The Manpower Development Act.

Apprenticeship Committee Members:

Mr. K. Ljunberg — Edmonton — Employer
Mr. T. Hudson — Edmonton — Employer
Mr. B. Zinger — Edmonton — Employer
Mr. R. Chambers — Edmonton — Employee
Mr. G. May — Edmonton — Employee
Mr. L. Hamilton — Calgary — Employer
Mr. S. Maeir — Calgary — Employer
Mr. V. Jewell — Calgary — Employee
Mr. H. Milne — Calgary — Employee
Mr. A. Jablonka — Calgary — Employee (Alternate)
Mr. G. Fithen — Calgary — Employer (Alternate)
Mr. J. Johnson — Red Deer — Employee

ELECTRONIC TECHNICIAN PROGRAM COURSE OUTLINE

This outline has been prepared in accordance with recommendations from the Provincial Apprenticeship Committee for the Electronic Technician Trade in the Province of Alberta.

The outline was updated following consideration given to recommendations and suggestions from:

- Local Apprenticeship Committees
- Representatives from training institutes
- Curriculum Sub-Committee from the Provincial Apprenticeship Committee

PROCEDURES FOR RECOMMENDING REVISION(S) TO THE COURSE OUTLINE

Any concerned citizen or group in the Province of Alberta may make recommendations for change by writing to Apprenticeship and Trade Certification, Edmonton.

It is requested that recommendations for change refer to specific areas and state references used. Recommendations received will be placed before regular meetings of the Provincial Apprenticeship Committee.

SAFETY EDUCATION

Safe working procedures and conditions, accident prevention and the preservation of health is of primary importance in the Apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of the government, employers, employees and the general public. Therefore, it is imperative that all parties become aware of circumstances that may lead to injury or harm and that safe learning experiences and environment can be created by controlling the variables and behaviors that may contribute to or cause an accident and/or an injury.

It is generally recognized that a safe attitude contributes to an accident free environment. As a result a healthy safe attitude towards accidents will benefit an employee by helping to avoid injury, loss of time and loss of pay.

A tradesman is possibly exposed to more hazards than any other person in the work force and therefore, should be familiar with the Occupational Health and Safety Act and Regulations dealing with his own personal safety and the special safety rules applying to each job.

LEGAL AND ADMINISTRATIVE ASPECTS

Employer's Responsibilities:

Accident prevention and the provisions of safe working conditions are the responsibilities of an employer. The company is responsible for:

1. The provision and maintenance of safety equipment
2. The provision of protective devices and clothing (as required by the Occupational Health & Safety Act, General Safety Regulations)
3. The enforcement of safe working procedures
4. Adequate safeguards for machinery, equipment and tools
5. Observance of all accident prevention regulations
6. Adequate training to allow a worker to use or operate equipment in an effective and safe manner.

Government's Responsibilities:

Apprenticeship and Trade Certification in conjunction with the respective Provincial Apprenticeship Committee assumes the responsibility to assure that adequate safety is reflected in the curriculum and that adequate safety instruction is presented at the training establishments.

The Occupational Health and Safety Inspection Branch assumes the responsibility for periodic inspection of the operation to ensure that regulations for industry are being correctly observed.

Individual's Responsibilities:

The employee is responsible for:

1. Knowing and working in accordance with the safety regulations pertaining to the job environment and
2. Working in such a way as not to endanger himself or his fellow employees

The major factor in safety is the individual employee, his personal attitude toward safety and having an awareness of the respective safety regulation.

ELECTRONIC TECHNICIAN PROGRAM

Subjects and Time Distribution

First Period	12 Weeks	30 Hours Per Week	360 Hours
Section One:	Basic Electronics Theory		132
Section Two:	Basic Electronics Lab.		144
Section Three:	Digitals Fundamentals Theory		36
Section Four:	Digital Fundamentals Lab.		24
Section Five:	Basic Mathematics		24
Second Period	12 Weeks	30 Hours Per Week	360 Hours
Section One:	Advanced Electronics Theory		120
Section Two:	Advanced Electronics Lab.		120
Section Three:	Advanced Digital Theory		60
Section Four:	Advanced Digital Lab.		60
Third Period	6 Weeks	30 Hours Per Week	180 Hours
Section One:	Television Theory		90
Section Two:	Television Lab.		90
Fourth Period	6 Weeks	30 Hours Per Week	180 Hours
Section One:	Microprocessor Applications Theory		48
Section Two:	Microprocessor Applications Lab.		48
Section Three:	System Troubleshooting Concepts Theory		36
Section Four:	Sytem Troubleshooting Concepts Lab.		48

FIRST PERIOD TECHNICAL TRAINING

SECTION ONE: BASIC ELECTRONICS (THEORY)

132 Hours

A. Fundamental Concepts of Electricity

1. Introduction
 - (a) practical application of general principles of electricity
 - (b) development of electronics
 - (c) radio communications and broadcast
 - (d) television broadcasting
 - (e) importance of trade terminology
2. Negative and positive polarities
3. Electrons and protons in an atom
4. Structure of an atom
5. The coulomb unit of charge
6. The volt unit of potential difference
7. Charge in motion — current
8. Resistance — opposition to current
9. The closed circuit
10. Direct current (D.C.) and alternating current (A.C.)
11. Sources of electricity

B. Ohm's Law

4 Hours

1. $I = \frac{E}{R}$, $E = IR$, $R = \frac{E}{I}$
2. Multiple and submultiple units
3. Linear proportion between E & I
4. Inverse relationship between I & R
5. Power dissipation in resistance
6. Electric shock

C. D.C. Circuits

24 Hours

1. Series
 - (a) current in series circuits
 - (b) total resistance
 - (c) voltage drops
 - (d) polarity of IR drops
 - (e) power in series circuits
 - (f) analyzing series circuits
 - (g) effects of an open in a series circuit

2. Parallel
 - (a) voltage across parallel branches
 - (b) branch current
 - (c) line current
 - (d) resistances in parallel
 - (e) conductances in parallel
 - (f) total power in parallel circuits
 - (g) analyzing parallel circuits
 - (h) effect of an open on a parallel circuit
3. Series-parallel
 - (a) finding R_T for series-parallel resistances
 - (b) resistance strings in parallel
 - (c) resistance banks in series
 - (d) resistance banks and strings in series-parallel
 - (e) analyzing series-parallel circuits

D. Direct Current Meters

4 Hours

1. Moving coil meter
2. Measurement of current
3. Meter shunt
4. Voltmeter
5. Ohmmeters
6. Multimeters
7. Digital Voltmeters D.V.M.s*
8. Digital Multimeters D.M.M.s*
9. Meter applications
10. Checking continuity with the ohmmeter

E. Conductors and Insulators

4 Hours

1. Purpose
2. Types
3. Standard wire gauge sizes
4. Switches
5. Fuses
6. Pilot lamps
7. Wire resistance
8. Ion current in liquids and gases
9. Electron and hole charges in semiconductors
10. Insulators

F. Resistors	4 Hours
1. Types	
2. Variable resistors	
3. Resistor color coding	
4. Power rating	
5. Choosing resistors for a circuit	
6. Series and parallel combinations of resistors	
7. Resistor troubles	
G. Batteries	4 Hours
1. Function of batteries	
2. The voltaic cell	
3. The carbon-zinc dry cell	
4. Series and parallel cells	
5. The lead-acid wet cell	
6. Types of electromotive cells, Nicad, Lithium*	
7. Internal resistance of a D.C. source	
8. Matching a load resistance to a source	
H. Magnetism	4 Hours
1. The magnetic field	
2. Magnetic flux	
3. Flux density	
4. Induction by the magnetic field	
5. Air gap of a magnet	
6. Types of magnets	
7. Magnetic shielding	
8. Permeability	
9. B-H magnetization curve	
10. Magnetic hysteresis	
I. Electromagnetic Induction	4 Hours
1. Magnetic field around an electric current	
2. Magnetic polarity of a coil	
3. Motor action between two magnetic fields	

4. Induced current
5. Lenz's law
6. Generating an induced voltage
7. Faraday's Law of induced voltage

J. Alternating Voltage and Current

7 Hours

1. Alternating-voltage generator
2. The sinewave
3. Alternating current
4. Voltage current values for a sinewave
5. Frequency and wavelength
6. Phase angle
7. Time factor in frequency and phase
8. A.C. circuits with resistance
9. The 60 Hz A.C. power line
10. Motors and generators
11. Non-sinusoidal A.C. waveforms
12. Harmonic frequencies

K. Inductance, Inductive Reactance and Inductive Circuits

10 Hours

1. Induction by alternating current
2. Self-inductance
3. Self-induced voltage
4. How E_L opposes a change in voltage
5. Mutual inductance
6. Transformers
7. Core losses and types of cores
8. Variable inductance
9. Inductances in series and parallel
10. Stray inductance
11. Trouble in coils
12. How X_L reduces amount of alternating current
13. $X_L = 2\pi f_L$
14. Series and parallel inductive reactances

15. Ohm's Law applied to X_L
16. Application of inductive reactance
17. Waveshape of E_L induced by sinewave current
18. Current and voltage phase relation in series and parallel
19. Inductive reactances and resistances in series and parallel
20. L/R time constant
21. High voltage produced by opening RL circuits
22. Comparison of time constant and reactance

L. Capacitance, Capacitive Reactance and Capacitive Circuits 10 Hours

1. How charge is stored in the dielectric
2. Charging and discharging capacitors
3. Unit of capacitance
4. Typical capacitors
5. Capacitor color coding
6. Capacitances in series and parallel
7. Stray capacitive and inductive effects
8. Energy in electrostatic field of capacitance
9. Troubles in capacitors
10. How A.C. voltage produces A.C. current in capacitive circuit
11. $X_C = \frac{1}{2\pi fC}$
12. Series and parallel capacitive reactances
13. Ohm's Law applied to X_C
14. Application of capacitance reactance
15. Charge and discharge current
16. Voltage and current phase relationships in capacitive circuits
17. Capacitive reactance in series and parallel circuits
18. Capacitive voltages dividers
19. R.F. and A.F. coupling capacitors
20. R.C. time constant and wave shapes
21. Long and short time constants
22. Universal time constant graph
23. Comparison of time constant and reactance

M. Alternating Current Circuits**6 Hours**

1. A.C. resistive circuits
2. A.C. inductance circuits
3. A.C. capacitive circuits
4. Opposite reactances
5. Reactances and resistances in
 - (a) series
 - (b) parallel
6. Real power
7. A.C. meter and wattmeters
8. Types of phasors in A.C. circuits

N. Resonance**3 Hours**

1. The resonance effect
2. Series resonance
3. Parallel resonance
4. Calculating resonant frequency
5. Q magnification factor
6. Bandwidth of a resonant circuit
7. Tuning
8. Mistuning
9. Analysis of parallel resonant circuits
10. Damping of parallel resonant circuits
11. Choosing L and C for a resonant circuit

O. Filters**6 Hours**

1. Examples of filtering
2. Direct current combined with A.C.
3. Transformer coupling
4. Capacitive coupling
5. Bypass capacitors
6. Filter circuits
7. Low pass filters
8. High pass filters
9. Interference filters

P. Semiconductor Diodes

6 Hours

1. Introduction
2. Types
3. Characteristics
 - (a) germanium
 - (b) silicon
4. Conductors
 - (a) hole concept
 - (b) free electron movement
 - (c) n-type doping (impurities added)
 - (d) p-type doping (impurities added)
 - (e) minority carriers
 - (f) majority carriers
5. Type P-N Junction Diode
 - (a) forward voltage
 - (b) reverse voltage
 - (c) voltampere characteristic
 - (d) diode symbols and ratings
 - (e) diode rectifier circuits
 - (i) half-wave
 - (ii) full-wave
 - (iii) operating characteristics
6. Zener and varactor diodes
 - (a) symbols and ratings
 - (b) characteristics
 - (c) applications
7. Thyristors
 - (a) types
 - (i) silicon controlled rectifier
 - (ii) diac
 - (iii) triac
 - (b) symbols and ratings
 - (c) characteristics
 - (d) applications

Q. Transistors

4 Hours

1. NPN and its symbol
2. PNP and its symbol
3. Transistor principle and action
4. Emitter base and collector current
5. Biasing transistors

6. Characteristic curves
 - (a) general description
 - (b) reading the collector characteristics
 - (c) delta values
 - (d) regions of operation
 - (e) input and temperature curves
7. Transistor amplifier configurations

R. Common Base Circuit

4 Hours

1. Characteristics — Alpha
2. General description
3. Biasing methods
4. Q-point analysis
5. D.C. equivalent circuits
6. Circuit limits — large signal, small signal
7. Circuit examples

S. The Common Emitter (CE) Circuit

4 Hours

1. Characteristics — Beta
2. Methods of biasing
3. Q-point analysis
4. D.C. equivalent circuits
5. Signal inversion
6. Temperature characteristics
7. Circuit limits — large signal, small signal
8. Circuit examples

T. Common Collector Circuit

4 Hours

1. General description
2. Circuit operation
3. Biasing and emitter follower
4. Q-point analysis
5. Signal response
6. Equivalent circuit
7. Applications
8. Circuit examples

U. Transistor Circuits	4 Hours
<ul style="list-style-type: none"> 1. Circuit components 2. Beta-dependent circuits 3. Biasing and emitter follower 4. Bias 5. Basic ideas of signal conditions 6. Amplifier-circuit characteristics 7. Coupling methods 8. Circuit limits 	
V. Field-Effect Transistors	4 Hours
<ul style="list-style-type: none"> 1. Symbol and general description 2. Characteristics and application 3. Junction-gate field-effect transistors (JFETs) <ul style="list-style-type: none"> (a) symbol and general description (b) application 4. Metal-oxide semiconductor field-effect transistor (MOSFETs) <ul style="list-style-type: none"> (a) types and symbols (b) application 	
W. Power Supplies	8 Hours
<ul style="list-style-type: none"> 1. Function 2. Power transformer 3. Rectifiers <ul style="list-style-type: none"> (a) half-wave (b) bridge (c) voltage doublers (d) voltage triplers 4. Transformerless power supplies 5. Typical A.C. power supply 6. Voltage regulators 7. Regulated power supply 8. Power supply problems 	

SECTION TWO:	BASIC ELECTRICITY (LAB)	144 Hours
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General Objectives:

- 1. To give an apprentice an understanding of proper and safe use of trade test equipment and instruments.

2. To assist in the development of essential trade skills and systematic troubleshooting procedures. Arranging and carrying out well-planned shop activities relating to the basic function of components and circuits found in the Electronic Technician Trade. By instruction in the use of modern test instruments, to further increase productivity.
3. To reinforce theoretical instruction by enabling the apprentice to gain practical circuit knowledge.

A. Orientation 4 Hours

1. Shop rules and procedure
2. Safety
3. Basic components and their symbols
4. Schematic diagrams
5. Soldering

B. Meters 7 Hours

1. Proper use and care
2. Function and range switches
3. Ranges
4. Meter error
5. Meter leads
6. Safety precautions
7. Resistor color code
8. Measuring resistance

C. Dry Cells 4 Hours

1. Series
 - (a) opposing
 - (b) aiding
2. Parallel
3. Series-Parallel
4. Care and application
5. Measuring D.C. voltages

D. D.C. Power Supply 2 Hours

1. Low voltage, high current sources
2. High voltage, low current sources
3. Application

4. Voltage measurements
5. Current measurements
6. Internal resistance

E. The Series Circuit

6 Hours

1. Live current
2. Voltage and voltage drop
3. Total resistance and total power
4. Application of Ohm and Kirchhoff's Laws
5. Series circuit design considerations
6. Troubleshooting

F. Parallel Circuit

6 Hours

1. Total resistance
2. Live current
3. Branch current
4. Voltage and voltage drops
5. Power and resistance characteristics
6. Application of Ohm and Kirchhoff's Law
7. Parallel circuits design considerations
8. Troubleshooting

G. Series-Parallel Circuit

6 Hours

1. Current
 - (a) branch
 - (b) total
2. Voltage
 - (a) applied and across each branch
 - (b) across each component
3. Total resistance and total power
4. Checking resistors for open
5. Troubleshooting

H. Voltage Divider Circuits

6 Hours

1. Loaded and unloaded
2. Series connected

3. Variable
4. Design considerations

I. Meters

1. Meters movement
 - (a) sensitivity
 - (b) internal resistance
2. Ammeter shunts
3. Voltmeter multipliers
4. Input resistance of voltmeters
5. Ohmmeters
6. D.V.M.'s use of (digital voltmeters)
7. D.M.M.'s use of (digital multimeters)
8. Precautions when using

J. Cathode Ray Oscilloscope

6 Hours

1. Function, use and care
2. Operation of single trace, dual trace
3. Operation of delayed sweep
4. Application

K. Alternating Current and Voltage

4 Hours

1. Sine wave
 - (a) peak value
 - (b) r.m.s. value
 - (c) cycle
 - (d) frequency
 - (e) wavelength
2. Angular measure
3. Radian measure
4. Phase angle

L. Inductance (Coils) and Inductive Reactance

9 Hours

1. Inducing a voltage in a coil
 - (a) electromagnetic induction
 - (b) polarity and magnitude
2. Inductance and reactance of a coil
3. Resistance of a coil
4. Effect of inductance on current in D.C. and A.C. circuits

5. Measurement of X_L
6. Verify that $X_L = 2\pi f_L$
7. Back E.M.F.
8. Phase relations between I and E in inductive circuits
9. Open coil
10. RL time constant

M. Transformers

3 Hours

1. Ideal transformer
2. Power losses
3. Effect of load current on primary current
4. Resistance-testing transformer windings
5. Turns ratio
6. Application

N. Capacitors, Capacitance and Capacitive Reactance

9 Hours

1. Color code
2. Capacitors in series and parallel
3. Determining value of capacitors
4. Effects of capacitance on current in D.C. and A.C. circuits
5. Measurement of X_C
6. Verify that $X_C = \frac{1}{2\pi fC}$
7. Phase relations between I and E in capacitive circuits
8. R.C. time constants
9. Testing capacitors for:
 - (a) open
 - (b) short
10. Capacitive voltage dividers

O. Series RCL Circuits

6 Hours

1. Impedance of series R.C. circuit
2. Impedance of series R.L. circuit
3. Verify that $Z = \sqrt{R^2 + (X_L - X_C)^2}$
4. Current and voltage

5. Series resonant circuit

- (a) $f_r = \frac{1}{2\pi\sqrt{LC}}$
- (b) line currents
- (c) impedance and voltage
- (d) circuit Q and frequency response
- (e) circuit Q and bandwidth
- (f) application

P. Parallel RLC Circuits

6 Hours

- 1. Current and voltage
- 2. Impedance
- 3. Parallel and series resonant circuits
 - (a) line current
 - (b) impedance and voltage
 - (c) application

Q. Filters

3 Hours

- 1. Circuits
- 2. Low pass
- 3. High pass
- 4. Frequency response curves

R. Phase Shift Networks

3 Hours

- 1. RC phase-shifting network
- 2. Phase-shifting bridge circuit

S. Thermistors and Varistors (V.D.R.'s)

2 Hours

- 1. Characteristics
- 2. Types
- 3. Applications

T. Semiconductor Diodes

18 Hours

- 1. Junction diodes
 - (a) characteristics
 - (b) operation
 - (c) testing
 - (d) application
- 2. Zener diodes
 - (a) characteristics
 - (b) operation
 - (c) ratings

- (d) application
- (e) design considerations
- 3. Varactor diodes
 - (a) characteristics
 - (b) rating
 - (c) operation
 - (d) application
- 4. Half-wave and full-wave rectification
 - (a) voltampere characteristics of silicon rectifiers
 - (i) transformerless
 - (ii) transformer type
- 5. Transformer power supply and filter
 - (a) operation
 - (b) regulation
 - (c) application
- 6. The voltage doubler using silicon rectifiers
 - (a) transformerless
- 7. Bridge rectifier
 - (a) transformer operated
 - (b) operation and overload protection
 - (c) filtering output
 - (d) troubleshooting
- 8. Servicing of power supply systems

U. Transistor Familiarization

6 Hours

- 1. Structure and symbols
- 2. Junction-transistors
 - (a) N.P.N.
 - (b) P.N.P.
- 3. Forward and reverse bias
- 4. Measurements in transistor circuits
- 5. Testing procedures
- 6. Characteristic curves
- 7. Thermal runaway
- 8. Ratings

V. Common Base Amplifiers (CB)

7 Hours

- 1. Circuit arrangement
- 2. Current gain — Alpha
- 3. Voltage gain

4. Power gain
5. Input and output impedance
6. Phase relations
7. Biasing methods
8. Application and operation
9. Troubleshooting a CB amplifier

W. Common Emitter Amplifiers (CE)

10 Hours

1. Circuit arrangement
2. Current gain — Beta
3. Average collector characteristics (VCE versus IC)
4. Voltage gain
5. Power gain
6. Input and output impedance
7. Phase relations
8. Biasing methods and stabilization
9. Emitter bypass capacitor
10. Voltage divider bias
11. Troubleshooting a common emitter amplifier
12. Application and operation

X. Common Collector Amplifiers (CC) Emitter Follower

5 Hours

1. Circuit arrangement
2. Current gain
3. Voltage gain
4. Power gain
5. Input and output impedance
6. Phase relations
7. Biasing methods
8. Application and operation
9. Troubleshooting an emitter follower

SECTION THREE: DIGITAL FUNDAMENTALS THEORY

36 Hours

A. Number Systems Used in Digital Electronics

1. Binary
2. Binary coded decimal

3. Octal
4. Hexadecimal
5. Other codes, i.e. ASCII

B. Basic Logic Gates

1. Introduction to Boolean Algebra
2. AND Gate
3. OR Gate
4. NOT Gate
5. Truth Tables
6. Combinational Logic Circuits

C. Other Logic Gates

1. NAND Gate
2. NOR Gate
3. Exclusive — OR Gate
4. Exclusive — NOR Gate
5. Converting gates using inverters
6. Combinational logic circuits

D. Flip-Flops

1. Introduction
2. RS Flip-Flop
3. Clocked RS Flip-Flop
4. D Flip-Flop
5. JK Flip-Flop
6. Triggering of Flip-Flops

E. Counters, Encoders and Registers

1. Counters
 - (a) asynchronous
 - (b) synchronous
2. Ripple counter
3. MSI counter circuits
4. Code conversion
 - (a) encoding
 - (b) decoding

5. Shift Registers
 - (a) serial-load shift register
 - (b) parallel-load shift register
 - (c) universal shift register

F. Digital Arithmetic

1. Binary addition
2. Binary subtraction
3. Binary multiplication

G. Application of Digital Integrated Circuits

1. Families
 - (a) LSI
 - (b) MSI
 - (c) SSI
 - (d) VLSI
2. Bipolar Families
 - (a) RTL
 - (b) DTL
 - (c) TTL
 - (d) ECL
3. MOS Families
 - (a) PMOS
 - (b) NMOS
 - (c) CMOS

SECTION FOUR: DIGITAL FUNDAMENTALS LAB

24 Hours

A. Lab Familiarization

1. Orientation
2. Procedures
3. Proper use of test equipment
4. Safety

B. Logic Gates

1. Operation
2. Troubleshooting

C. Combinational Logic Circuits

1. Operation
2. Troubleshooting

- D. Flip Flops**
 - 1. Operation
 - 2. Troubleshooting
- E. Counters and Registers**
 - 1. Operation
 - 2. Troubleshooting
- F. Logic Families**
 - 1. Characteristics
 - 2. Specifications

SECTION FIVE:

BASIC MATHEMATICS

24 Hours

A. Basic Mathematics

8 Hours

- 1. Review of:
 - (a) whole numbers
 - (b) common fractions
 - (c) decimal fractions
 - (d) percentage
 - (e) factoring
 - (f) ratio and proportion
 - (g) fundamentals of algebra
 - (h) equation transposition
- 2. Powers of ten
 - (a) scientific notation
 - (i) multiply
 - (ii) divide
 - (iii) raise to a power
 - (iv) add and subtract
 - (b) electronic calculator
 - (i) proper use
 - (ii) electronic notation

B. Logarithms

5 Hours

- 1. Definition of common logarithms
- 2. Laws of logarithms
- 3. Use of logarithmic tables
- 4. Application of logarithms

C. Decibels

6 Hours

- 1. Objectives
- 2. Definition of the decibel

3. Voltage ratios in decibels
4. Current ratios in decibels
5. Standard references
6. Using decibel measurements
7. Acoustical measurement
8. Electrical measurement in decibels

D. Trigonometric Functions

5 Hours

1. Properties of a right angle triangle
2. Trigonometric ratios
 - (a) sine
 - (b) cosine
 - (c) tangent
3. Solution of right angle triangles
4. Trigonometric solution of A.C. circuits
 - (a) voltage
 - (b) current
 - (c) phase angle
 - (d) power
 - (e) impedance

SECOND PERIOD TECHNICAL TRAINING

SECTION ONE: ADVANCED ELECTRONICS THEORY

120 Hours

A. Power Supplies

1. Basic function
2. Power transformers
3. Rectifiers (Transformer Driven)
 - (a) half-wave
 - (b) full-wave
 - (c) bridge
 - (d) voltage doublers
 - (e) voltage triplers
4. Transformerless power supplies
5. Voltage regulators
 - (a) zener diode regulator
 - (b) series regulator
 - (c) shunt regulator
 - (d) I.C. regulator
 - (e) current limiting

B. Audio Voltage Amplifiers

1. Linear Amps (define)
2. Class of operation
3. Factors affecting bandwidth
4. Type of coupling used
5. Phase inverters
6. Distortion
 - (a) types
 - (b) causes
7. Negative feedback
 - (a) define
 - (b) types
 - (c) advantages and disadvantages
8. Volume and tone control circuits
9. Differential amplifiers
10. Operational amplifiers
11. Active filters

C. Power Amplifiers (Audio)

1. Function
2. Transformer
3. Transformerless
4. Complementary
5. Complementary Darlington
6. Quasi complementary
7. Power supplies
 - (a) single
 - (b) split
8. Thermal — stability requirements
9. Short — circuit protection
10. Classes of operation
11. Circuit operations
12. Component functions

D. A.M. Modulation Principles

1. R.F. carrier (define)
2. Effects of the audio modulating signal on the R.F. carrier
3. Sideband frequencies and their relation to the audio signal
4. Percent modulation
5. A.M. power distribution
6. A.M. stereo (Principles)

E. R.F. Amplifiers

1. Functions
2. Type of amplifier configuration
 - (a) common emitter
 - (b) common base
3. Type of input and output circuits used
4. Class of operation
5. Type of bias used
6. Circuit operation and component functions
7. Neutralization
 - (a) function
 - (b) circuit operation

F. Oscillators

1. Function
2. Type of oscillators commonly used
3. Class of operation
4. Type of bias used
5. Frequency determining components
6. Circuit operation and component functions
7. Voltage controlled oscillators (V.C.O.'s)

G. Converters (Mixers)

1. Type of input and output circuits and signals used.
2. Basic function
3. Class of operation
4. Bias used
5. Advantage of mixers as compared to converters
6. Circuit operation and component functions

H. I.F. Amplifiers

1. Function
2. Type of input and output circuits and signals used
3. Type of bias used
4. Class of operation
5. Circuit operation and component functions
6. Neutralization

I. I.M. Detectors

1. Function
2. Circuit operation and component function

J. Automatic Volume Control Circuits (A.V.C.)

1. Function
2. Types
 - (a) forward and
 - (b) reverse (A.V.C.)
3. Advantage and disadvantages of A.V.C.
4. Delayed A.V.C.

5. Auxiliary A.V.C.

6. Circuit operation and component functions

K. A.M. Stereo Receiver Circuit Analysis

1. Operation of varied types of AM receivers (stereo)

2. Trouble shooting methods

L. F.M. Modulation Principles

1. Effect of the audio modulating voltage and frequency on carrier

2. Advantages of F.M. as compared to A.M.

3. Associated sideband frequencies

4. Pre-emphasis

5. Percent modulation

6. The F.M. broadcast band

7. Capture effect

M. F.M. Receivers

1. R.F. carriers

2. I.F. carrier

3. Circuit operation of:

(a) R.F.

(b) mixer

(c) oscillator

(d) I.F. circuits

N. Limiters

1. Function

2. Circuit — operation

O. F.M. Detectors

1. Function

2. Types

(a) discriminating

(b) ratio

(c) quadrature

(d) phase-locked loop (P.L.L.) Detectors

3. Operation of each type of detector and component functions

4. De-emphasis

5. Detector alignment

- (a) visual
- (b) voltmeter

P. Automatic Gain Control (A.G.C.) Circuits

- 1. Function
- 2. Circuit operation and component functions

Q. Automatic Frequency Control Circuits (A.F.C.)

- 1. Function
- 2. Circuit operation and component function

R. Complete F.M. Receiver

- 1. Stage function
- 2. Component function
- 3. Alignment
- 4. Servicing F.M. receivers

S. F.M. Multiplex

- 1. F.M. multiplex system
 - (a) $L+R$ and $L-R$ signals
 - (b) Pilot signal
 - (c) sub-carrier modulators
 - (d) SCA signal
 - (e) transmission standards
- 2. Stereo detector circuits
 - (a) circuit operation and component function
 - (b) stereo receiver servicing
 - (c) stereo receiver alignment
 - (d) operation of AM-FM receivers

T. Tape Recorders

- 1. Tape recorder types
 - (a) reel to reel
 - (b) cassette
- 2. Block diagram and physical layout
- 3. Principles of operation
 - (a) record
 - (b) playback
 - (c) biasing
- 4. Frequency response
- 5. Wow and Flutter

6. Bias oscillator and biasing
7. Tape speeds and their effect on frequency response
8. Equalization
9. Tape recorder circuits and their operation
10. Motors and speed control methods
11. Servicing tape recorders
12. Dolby systems

U. Varactors, S.C.R.'s, Diacs and Triacs

1. Characteristics
2. Schematic symbols
3. Applications
4. Operation

V. Reproducers

1. Cartridges (phono)
 - (a) types (mono, stereo ceramic and magnetic)
 - (b) operation
2. Microphones
 - (a) types (crystal, dynamic)
 - (b) operation

SECTION TWO: ADVANCED ELECTRONICS LAB

120 Hours

A. Audio Amplifiers

1. Audio voltage amplifiers
 - (a) gain
 - (b) frequency response
 - (i) R-C coupled
 - (ii) Transformer coupled
 - (iii) D-C coupled
 - (c) feedback circuit analysis
 - (d) servicing
2. Audio power amplifiers
 - (a) single ended
 - (i) power gain
 - (ii) frequency response
 - (iii) servicing
 - (b) push-pull power amplifiers
 - (i) class A and AB
 - (ii) transformer coupled
 - (iii) transformerless

- (iv) frequency response
- (v) power gain
- (vi) servicing

B. I.C. — A.M. Modulators Principles

1. Effect of audio voltage level and frequency on R.F. carrier
2. Effect of class of operation on R.F. carrier

C. Integrated Circuit R.F. and I.F. Amplifier Circuits

1. Coupling methods
2. Bandwidth
3. Alignment
4. Servicing

D. Oscillators (sine-wave)

1. Hartley and Armstrong
 - (a) frequency determining components
 - (b) effects of voltmeters on oscillator operation
 - (c) servicing
 - (d) integrated circuit oscillators

E. Mixers (Converters)

1. Coupling
2. Signal inputs
3. Signal outputs
4. Servicing

F. Detectors and A.V.C.

1. Basic detector circuit
 - (a) filtering
 - (b) detected D.C. levels
2. A.V.C. circuit
 - (a) effect of signal level on A.V.C. voltage level
3. Servicing

G. A.M. Radio Receivers

1. Circuit analysis of all stages
2. Alignment
3. Servicing procedures

H. F.M. Radio Receivers (Mono and stereo)

1. Circuit analysis of all stages
2. Alignment
3. Servicing procedures

I. Record Changers

1. Motors — AC and DC
2. Mechanical operation
3. Speed control systems
4. Drive mechanisms — cleaning, lubrication and adjustments
5. Cartridges
 - (a) checking

J. Tape Recorders

1. Performance check
 - (a) frequency response
 - (b) distortion (I.M.D. and Harmonic) intermodulation, distortion
 - (c) wow and flutter
 - (d) signal-noise-ratio
2. Adjustments
 - (a) tape guide
 - (b) heads
 - (c) oscillator (bias)
 - (d) equalizing circuits
 - (e) speed
 - (f) hum
 - (g) demagnetization of tapes and heads
 - (h) cleaning of heads and tape guides
3. Circuit fault analysis

K. Special Devices

1. Varactors
2. S.C.R.'s
3. Diac's
4. Triac's

L. Phase Locked Loop (P.L.L.) Circuit

1. Operation
2. Servicing (checking of input and output signals and voltages)

M. Operational Amplifiers

1. Inverting circuit
2. Non-inverting circuit
3. Feedback circuits
4. Input and output impedances
5. Active filters

SECTION THREE: ADVANCED DIGITAL THEORY

60 Hours

A. Encoding

1. Definition
2. Applications
3. Types
 - (a) octal to binary
 - (b) switch encoders
 - (c) priority
 - (d) decimal to BCD
4. Circuit operations
5. Truth tables

B. Decoders

1. Define
2. Applications
3. Types
 - (a) BCD to decimal
 - (b) BCD to 7-segment decoder/drivers
 - (c) Binary to octal
4. Enable inputs (function)
5. Circuit operation
6. Truth table

C. Multiplexers (Data Selectors)

1. Define
2. Applications
3. Types
 - (a) 2 input
 - (b) 4 input
 - (c) 8 input
 - (d) quad two-input

4. Truth tables
5. Circuit operations

D. Demultiplexers (Data Distributors)

1. Define
2. Applications
3. Types
 - (a) one-line-to-8-line
 - (b) clock
4. Truth tables
5. Circuit operations

E. Tri-State Devices

1. Function
2. Operation
3. Logic symbol

F. Digital to Analog Conversion

1. DIA — Converter circuitry
2. DAC specifications
3. DAC applications
4. Analog to digital conversion
5. Digital ramp, A/D converter
6. Successive approximation ADC
7. Digital voltmeter

G. Sample And Hold Circuits

1. Circuit
2. Function
3. Operation

H. Memory Devices

5 Hours

1. Memory terminology
2. General memory operation
3. Read — only memories— ROMS
4. ROM architecture
5. ROM timing

6. Types of ROMS
7. ROM applications
8. Random access memory (RAM)
9. RAM architecture
 - (a) read/write operation
 - (b) chip select
 - (c) common input/output data lines
10. Static and dynamic RAM
11. Dynamic RAM structure and operation

I. Microprocessor Concepts

15 Hours

1. Basic functions
2. Major functional sections
 - (a) register section
 - (b) control and timing section
 - (c) A.L.U. section

SECTION FOUR: ADVANCED DIGITAL LAB

60 Hours

A. Encoding

1. Octal to binary
2. Decimal to BCD
3. Switch encoders
4. Priority encoders

B. Decoders

1. Binary to octal
2. BCD to decimal
3. BCD to 7 segment decoder/drivers

C. Multiplexers

1. 2, 4 and 8 input
2. Quad two input

D. Demultiplexers

1. One-line to 8 line
2. Clock

E. Tri-state register

1. Load operation
2. Hold operation
3. Output data operation
4. Data transfer operation

F. DIA Converter

1. OP — AMP summing amplifier circuit

G. A/D Converter

1. 8 bit A/D converter circuit, analysis

H. Microprocessors Concepts

15 Hours

THIRD PERIOD TECHNICAL TRAINING

SECTION ONE:

TELEVISION THEORY

90 Hours

A. Television Receivers

1. Characteristics of the eye
2. Picture transmission
3. Raster formation
4. Horizontal deflection and interface scanning
5. The seven-line raster
6. The video signal
7. Picture reproduction
8. The composite video signal
9. The modulated video signal
10. Block diagram of a monochrome receiver

B. Principles of Color Television

1. Definition of color terms
2. Color television transmission
3. Phase relationships
4. Development of the chrominance signal
5. I and Q signals
6. Frequency interleaving
7. Composite chrominance signal
8. Block diagram of a color receiver

C. The Front End

1. The VHF tuner
2. Drum-type tuners
3. Switch type tuners
4. Electronic tuning
5. The RF amplifier
6. The mixer
7. The oscillator

8. Tuner troubleshooting
9. Typical tuner response curve

D. Automatic Fine Tuning (AFT)

1. Effects of oscillator drift
2. AFT circuits
3. AFT alignment
4. Troubleshooting the AFT circuit

E. Video IF Amplifiers

1. The intermediate frequency
2. The video IF strip
3. Intercarrier sound
4. Typical IF response (monochrome & color)
5. IF traps
6. Coupling methods
7. The video detector
8. Troubleshooting the video IF amplifier and detector

F. Automatic Gain Control (AGC)

1. Basic function
2. The ideal AGC system
3. Gain control methods
4. AGC methods
5. Keyed AGC
6. AGC level controls
7. Troubleshooting AGC systems

G. The Sound Circuitry

1. Introduction
2. Sound IF amplifiers
3. Typical sound IF circuit
4. The ratio detector
5. Integrated circuit detectors
6. Troubleshooting the sound strip

H. Picture Tubes

1. Basic structure
2. The electron gun
3. Ion burns
4. Flat picture tubes
5. The color picture tube
6. The phosphor screen
7. the shadow mask
8. Purity
9. Automatic degaussing circuit
10. Purity adjustments
11. Convergence — static and dynamic
12. Convergence — adjustments
13. Pin cushion cause and correction
14. The gray scale
15. Picture tube testing and troubleshooting
16. Projection TV

I. The Video Amplifiers

1. Picture tube light output characteristics
2. Amplifier distortion
3. Video frequency and picture content
4. High frequency compensation
5. Low frequency compensation
6. DC restoration
7. The comb filter
8. Video amplifier controls and typical circuits
9. Brightnes limiter
10. Peaking controls
11. Spot killer circuits
12. The delay line
13. Retrace blanking circuit
14. Video amplifier troubleshooting

J. Sync Separators

1. Function
2. Amplitude separation
3. Waveform separation-integrator and differentiators
4. Transistor sync separator
5. Vertical countdown circuits
6. Sync separator troubleshooting

K. Deflection Oscillators

1. The deflection oscillator and sawtooth formation
2. The discharge transistor
3. The trapezoid waveform
4. The sawtooth oscillator
5. The blocking oscillator
6. Multivibrators
7. Troubleshooting deflection oscillators
8. Automatic frequency control (AFC)
9. Types of AFC detectors
10. Antihunt circuits
11. Troubleshooting the AFC circuit

L. Vertical Deflection Circuits

1. Basic function
2. The vertical output stage and amplifier
3. Vertical linearity
4. Typical vertical deflection circuits
5. Transformerless vertical output amplifier
6. The Miller rundown vertical circuit
7. Vertical deflection circuit troubleshooting

M. Horizontal Output Amplifier

1. Function
2. Operation
3. Transistor horizontal output stage
4. The horizontal driver stage

5. The flyback transformer and yoke
6. Amplifier controls
7. High-voltage rectifier circuits
8. High-voltage focus supplies
9. High-voltage hold-down circuits
10. High-voltage regulation
11. The SCR horizontal deflection circuit

N. The Bandpass Amplifier

1. Functions and controls
2. The color bar generator
3. The transistor bandpass amplifier
4. The I.C. bandpass amplifier
5. Bandpass amplifier alignment
6. Troubleshooting the bandpass amplifier
7. The color killer
8. Automatic color control (ACC)

O. Color Sync Circuits

1. Introduction
2. The burst gate
3. Automatic frequency and phase control (AFPC)
4. The phase detector
5. The oscillator control circuit
6. The color oscillator
7. Injection-locked oscillator
8. Crystal ringing AFPC

P. Color Demodulators

1. Function and operation
2. The transistor demodulator
3. Demodulator types
4. Demodulator circuits
5. Troubleshooting
6. Automatic tint control and VIR

Q. Low-Voltage Power Supplies

1. Introduction and review
2. Regulator circuits
3. High-frequency power supplies
4. Scan-derived low voltage power supplies
5. Troubleshooting

R. Videocassette Recorders

1. Introduction
2. Principles of magnetic recording
3. Recording and playback heads
4. Tape format
5. Color crosstalk minimization
6. VHS recording system
7. BETA recording system
8. The servo system
9. Mechanical considerations
10. VCR protection circuits (System Control)
11. Audio recording system

SECTION TWO:

TELEVISION LAB

90 Hours

A. Safety

1. Picture tube handling
2. Electrically “hot” chassis
3. High voltage precautions
4. Leakage tests
5. Critical component replacement (safety components)

B. Tools and Equipment

1. Preliminary equipment — block diagram, component layout, schematic diagram
2. Isolation transformer
3. Multimeter
4. Oscilloscope

5. Low capacity probe (x10 probe)
6. Demodulator probe
7. High voltage probe
8. Current probe
9. DC bias box
10. Signal substitution generator (video analyzer)
11. Degaussing coil
12. Video signal generator
13. CRT tester

C. Television Receiver Controls and Adjustments

1. Operating controls
2. Service controls
3. CRT degaussing
4. High voltage adjustments
5. Convergence adjustments

D. The Front End

1. Incoming signal characteristics
2. The RF amplifier
3. The tuner oscillator
4. The mixer
5. Tuner substitution and maintenance

E. The Video IF Amplifier

1. Incoming signal characteristics
2. Circuit characteristics
3. DC voltage checks
4. Interstage coupling techniques
5. Use of the demodulator probe
6. Video detector signal output characteristics

F. AGC and AFT

1. Keyed AGC characteristics
2. Delayed AGC

3. AGC adjustments
4. Use of bias box to check AGC
5. AFT input signal characteristic
6. AFT output signal characteristics
7. AFT oscillator control

G. Picture Tubes

1. CRT operating conditions
2. CRT control adjustments
3. High voltage measurement
4. CRT dc biasing
5. Video signal effects on CRT

H. Video Amplifiers

1. Incoming signal characteristics
2. Controls associated with the stage
3. Output signal characteristics
4. Waveform checks in the video amplifier
5. Gain measurements
6. DC bias conditions
7. Automatic brightness limiter
8. Troubleshooting

I. Vertical and Horizontal Deflection Stages

1. Sync separator operation and waveform characteristics
2. Controls associated with the vertical stage
3. Vertical waveform characteristics
4. Vertical biasing characteristics
5. Vertical output amplifier characteristics
6. Horizontal AFC operation
7. Controls associated with the horizontal stage
8. Horizontal waveform characteristics
9. Horizontal biasing characteristics

10. Horizontal output amplifier characteristics
11. Flyback transformer operation
12. High voltage rectifier operation
13. High voltage regulation and shut down
14. Scan rectified supplier
15. The deflection yoke
16. Troubleshooting the deflection stages

J. Color Bandpass Amplifier Stage

1. Input and output signal characteristics
2. Controls associated with the stage
3. DC biasing of the stage
4. Circuit operation
5. Operation of the color killer circuit
6. Troubleshooting the stage

K. Color Sync and Demodulator Stage

1. Burst amplifier characteristics
2. Controls associated with the stage
3. DC biasing of the stage
4. Circuit operation
5. Color oscillator control
6. Demodulator output signal characteristics
7. Troubleshooting the stage

L. Video Cassette Recorders

1. Record mode;
 - (a) trace luminance and chrominance signal from the video input to the video heads
 - (b) note signal changes from stage to stage
 - (c) note controls associated with the stages
 - (d) trace the audio and control track signals from the input to the audio and control track heads
 - (e) observe the erase head signal
2. Playback mode
 - (a) trace the luminance and chrominance signal from the video heads to the video output jack

- (b) note signal changes from stage to stage
- (c) note controls associated with each stage
- (d) trace the audio and control track signals from the playback head to the audio output jack and the servo circuit

3. Drum servo circuitry

4. Capstan servo circuitry

FOURTH PERIOD TECHNICAL TRAINING

SECTION ONE: MICROPROCESSOR APPLICATIONS THEORY

48 Hours

A. Television Tuning

1. Block diagram of address system
 - (a) address functions performed by U.P.
 - (i) on-off
 - (ii) volume control
 - (iii) channel change etc.
 - (b) interfaces
 - (i) keyboard
 - (ii) remote pre-amp
 - (iii) cable/normal switch
 - (iv) frequency synthesizer
 - (v) led display assembly
 - (vi) volume shift register
 - (vii) on/off relay driver
2. Interface circuit analysis.

B. VCR Control

1. Type of U.P.s used
 - (a) tuning U.P.
 - (b) system control sub. U.P.
 - (c) system control main U.P.
 - (d) timer/tape counter control U.P.
2. Basic function of each U.P.
 - (a) pin function of each U.P.
 - (b) interfacing circuits
 - (c) manufacturers volt and waveform data

C. Personal Computers

1. C.P.U.
 - (a) assembling a program
2. Memory map
 - (a) C.P.U. addressing circuits
 - (b) relative addressing
 - (c) index register addressing
 - (d) the stack
 - (e) addressing with other registers
3. Clock
 - (a) function
 - (b) frequencies

4. Address and data buses
 - (a) connecting data lines
 - (b) digital components in the address lines
 - (c) components in the address lines
 - (d) assigning addresses
5. Synchronous address multiplexer (SAM)
 - (a) SAM block diagram
 - (b) system timing
 - (c) device selection
6. Asynchronous communication interface adapter (ACIA)
 - (a) ACIA block diagrams
 - (b) function
7. Peripheral interface adapter (PIA)
 - (a) basic functions
 - (b) pin functions

SECTION TWO: MICROPROCESSOR APPLICATIONS LAB

48 Hours

A. Television Tuning

1. Physical layout and component identification.
2. Manufacturers data.
3. With the aid of manufacturers data, check voltages and waveforms at prescribed system test points.
4. Trouble shooting methodology in compliance with manufacturers recommended procedures.

B. VCR Control

1. Component identification.
2. Voltage and waveform checks.
3. Trouble shooting procedures in compliance with manufacturers specifications.

C. Personal Computers

1. Check operation of:
 - (a) CPU
 - (b) clock
 - (c) address and data buses
 - (d) SAM's
 - (e) PIA's using voltmeter, probe and scope
2. Trouble shooting procedures
 - (a) peripheral equipment

A. Basic Troubleshooting Procedures

1. Value of schematic and service manuals
2. Knowledge of circuit operation
3. Knowledge of test equipment operation and measurement limitations
4. The universal troubleshooting approach
 - (a) determine the symptoms
 - (b) localize the fault to a functional section
 - (c) isolate the fault to a circuit
 - (d) locate the specific fault
5. Safety precautions in troubleshooting

B. Audio Circuit Tests

1. Basic audio amplifier test procedures
 - (a) frequency response
 - (b) gain
 - (c) power output
 - (d) power bandwidth
 - (e) input/output impedance
 - (f) harmonic distortion
 - (g) intermodulation distortion
 - (h) background noise
2. Troubleshooting small signal audio amplifiers
3. Troubleshooting medium power audio amplifiers
4. Troubleshooting high power audio amplifiers
5. Understanding and troubleshooting pulse width modulated amplifiers
6. Troubleshooting audio amplifiers with feedback

C. Regulated Power Supply Tests

1. Fundamentals of regulated power supplies
2. Fundamentals of pulse-width modulated (PWM) power supplies (also switching supplies)
3. Fundamentals of scan-derived supplies
4. Measurement of:
 - (a) ripple level and frequency
 - (b) regulation characteristics
5. Fundamentals of current limiting power supplies

D. AM Receiver Troubleshooting

1. D.C. current and voltage tests (static)
2. Analysis by signal injection
3. Analysis by signal tracing
4. AVC/AGC circuit checks
5. dynamic D.C. detector tests

E. FM Receiver Troubleshooting

1. FM signal-injection tests
2. Automatic frequency control (AFC) tests
3. Ratio detector tests
4. Troubleshooting stereo-multiplex circuitry
5. Stereo separation tests
6. Alignment of FM and detector circuitry

F. Differential and Operational Amplifier Servicing

1. Differential amplifier performance tests
2. Working with Op Amps
3. Voltage gain measurement
4. Input/output impedance measurement
5. Distortion measurement
6. Noise measurement
7. Slew rate measurement

G. Television Receiver Troubleshooting

1. Safety
2. Tuner/chassis trouble localization (tuner substitution)
3. IF amplifier troubleshooting
4. AGC troubleshooting
5. Video amplifier troubleshooting
6. Vertical sweep oscillator and output troubleshooting
7. Horizontal sweep oscillator and output troubleshooting
8. High voltage section troubleshooting
9. Color sync circuit troubleshooting
10. Color killer test procedure

11. Color demodulation servicing

12. Color matrix section

H. Videocassette Recorder Troubleshooting

1. Signal injection and tracing

2. Record/playback signal characteristics

3. Troubleshooting the servo circuitry

4. Checking the system control circuitry

5. Tape transport maintenance

6. Mechanical adjustments precautions

I. Digital Test Equipment

1. Oscilloscope

2. Multimeter

3. Logic probe/pulser

4. Current tracer

5. Logic clip

6. Logic comparator

7. Logic analyzer

8. Signature analyzer

J. Microprocessor-Based Digital Troubleshooting

1. System clock

2. Power-up reset (initialization)

3. Acceptable data levels

4. Interrupts

5. Self test ROM and RAM programs

6. Data and address bus system

7. Multiplexed I/O

8. Interfacing

**SECTION FOUR: SYSTEM TROUBLESHOOTING
CONCEPTS LAB**

48 Hours

A. Safety

B. Test Equipment

C. The universal troubleshooting approach

- D. Audio Circuit Tests and Troubleshooting**
- E. Regulated Power Supply Tests and Troubleshooting**
- F. AM Receiver Troubleshooting**
- G. FM Receiver Troubleshooting**
- H. Operational Amplifier Troubleshooting**
- I. Television Receiver Troubleshooting**
- J. Videocassette Recorder Troubleshooting**
- K. Digital Test Equipment**
- L. Digital Troubleshooting**
- M. Microprocessor-Based Digital Troubleshooting**

SUGGESTED REFERENCE MATERIALS

TROUBLESHOOTING TEXTS

1. Handbook of Basic Electronic Troubleshooting
John D. Lenk, Prentice-Hall
2. Advanced Electronic Troubleshooting
Derek Cameron, Reston Publishing
3. Practical Handbook of Solid State Troubleshooting
Robert C. Genn, Jr., Parker Publishing
4. Handbook of Advanced Solid-State Troubleshooting
Miles Ritter-Sanders, Jr., Reston Publishing

TECHNICAL TRAINING SCHOOLS

The Electronic Technician apprenticeship training program is offered by Alberta Manpower, Apprenticeship and Trade Certification. Staff and facilities for teaching the program are supplied by:

1. Northern Alberta Institute of Technology.
2. Southern Alberta Institute of Technology.

LOCATION OF APPRENTICESHIP AND TRADE CERTIFICATION REGIONAL OFFICES

BONNYVILLE

CALGARY

EDMONTON

FORT McMURRAY

GRANDE PRAIRIE

HINTON

LETHBRIDGE

MEDICINE HAT

PEACE RIVER

RED DEER

VERMILION

ALBERTA REGULATION 172/80
MANPOWER DEVELOPMENT ACT
ELECTRONIC TECHNICIAN TRADE REGULATION

1(1) In this regulation

- (a) "electronic technician" means a person engaged in the installation, repair and safety checks of radio and television receivers, recorders, phonographs and amplifiers;
- (b) "General Regulations" means the General Regulations (Alta. Reg. 43/77), as amended;
- (c) "trade" means the trade of electronic technician.

(2) The definitions in the General Regulations apply in this regulation.

AR 172/80

PART 1

APPRENTICESHIP AND TRADE TRAINING

2 A person is eligible to be an apprentice electronic technician if he has

- (a) satisfied the requirements of section 5 of the General Regulations, and
- (b) either
 - (i) produced evidence of at least a grade 10 education with not less than a "B" standing in Mathematics 10 or its equivalent, or
 - (ii) passed an entrance examination prescribed by the Board.

AR 172/80

3(1) Subject to subsections (1.1) and (2), an employer who is a journeyman or who employs a journeyman may employ one apprentice and one additional apprentice for each additional journeyman he employs.

(1.1) If the supply of journeymen in a location where an employer is carrying on business is insufficient to permit the employer to carry out his work commitments, the Director may authorize the employer to employ apprentices in addition to those permitted under subsection (1).

(2) The Director may authorize an employer to employ an apprentice on a temporary basis in addition to those permitted under subsection (1), to be trained in a branch of the trade not engaged in by the employer to whom he is apprenticed.

(3) An apprentice employed temporarily under subsection (2) shall not, for the purposes of subsection (1), be considered to be an apprentice of his temporary employer.

AR 172/80; 353/82

4(1) The term of apprenticeship shall be 4 periods of 12 months each.

(2) Each period shall consist of not less than 1800 hours of employment, including time spent attending technical training courses prescribed by the Board.

5 When a contract of apprenticeship is registered with the Director, he shall issue to the apprentice an official record book referred to in section 14 of the General Regulations.

AR 172/80

6(1) An apprentice shall not advance to the next period until the Director has authorized him to do so by making an entry in the apprentice's official record book under subsection (2).

(2) The Director shall make an entry in the apprentice's official record book authorizing advancement to the next period, when the apprentice

(a) has completed the previous period of apprenticeship,

(b) has received, in the opinion of the Director, a satisfactory report from

(i) his employer, and

(ii) the school at which he attended technical training courses prescribed by the Board,

(c) has completed the tests and examinations prescribed by the Board, and

(d) has attained pass marks prescribed by the Board in the tests and examinations referred to in clause (c).

AR 172/80

7 The official record book of an apprentice shall be kept in the possession of his employer and, upon termination of the employment of the apprentice, the employer shall present the book to him.

AR 172/80

8(1) An employer shall pay wages to the apprentice that are not less than the following percentages of the prevailing wages paid to a journeyman:

(a) 50% in the first period;

(b) 60% in the 2nd period;

(c) 70% in the 3rd period;

(d) 80% in the 4th period.

(2) Notwithstanding subsection (1), the wages paid to an apprentice shall not be less than the minimum wage fixed pursuant to *The Employment Standards Act*.

(3) An employer is not required to pay an apprentice wages during the time that the apprentice spends attending technical training courses prescribed by the Board.

AR 172/80

9 The hours of work and working conditions of an apprentice shall be the same as those of a journeyman.

AR 172/80

PART 2

CERTIFICATION

10 The Director may issue the following classes of certificates in accordance with section 49 of the General Regulations:

- (a) Certificate of Proficiency;
- (b) Temporary Certificate.

AR 172/80

11 In accordance with section 50(d) of the General Regulations, the Director may issue a Certificate of Proficiency for the trade without examination to a person who holds

- (a) a Certificate of Completion of Apprenticeship in the trade issued by another province within Canada prior to January 1, 1965.
- (b) a Certificate of Qualification or a Certificate of Proficiency in the trade issued by another province within Canada bearing an Interprovincial Standards Red Seal.

AR 172/80

12(1) An application to take an examination for a Certificate of Proficiency shall be made to the Director.

(2) Documentary evidence acceptable to the Director shall be presented by the applicant for an examination showing that the applicant

- (a) holds a certificate equivalent to an Alberta Certificate of Proficiency issued by a recognized provincial authority outside of Alberta, or
- (b) has at least 5 years of acceptable work experience in the trade.

(3) The applicant shall provide translations into the English language acceptable to the Director, of credentials in a language other than in English submitted pursuant to subsection (2).

AR 172/80

12.1(1) The Director may issue a Temporary Certificate to a person if

- (a) the person complies with section 12,
- (b) the Director approves the application for examination, and
- (c) the person attains a mark of not less than 70% of the passmark, on the examination prescribed by the Board for a Certificate of Proficiency.

(2) Notwithstanding subsection 1(c) the Director may, if in his opinion extenuating circumstances warrant such action, issue a Temporary Certificate to a person who has attained less than 70% of a passmark on the examination prescribed by the Board.

(3) A Temporary Certificate entitles the holder to work in the trade under the supervision of a journeyman.

AR 353/82

13 A Certificate of Proficiency issued under this regulation is effective unless cancelled or suspended by the Director in accordance with section 60 or 61 of the General Regulations.

AR 172/80

14 Regulations with Respect to the Trade of a Radio Technician (Alta. Reg. 451/67) and Regulations Governing the Trade of a Radiotechnician (Alta. Reg. 157/57), as amended, are repealed.

AR 172/80



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